CHAPTER 4 (Odd)

1. $V = IR = (2.5 \text{ A})(6 \ \Omega) = \mathbf{15 \ V}$

3. $R = \dfrac{V}{I} = \dfrac{6 \text{ V}}{1.5 \text{ mA}} = \mathbf{4 \ k\Omega}$

5. $V = IR = (3.6 \ \mu\text{A})(0.02 \text{ M}\Omega) = 0.072 \text{ V} = \mathbf{72 \ mV}$

7. $R = \dfrac{V}{I} = \dfrac{120 \text{ V}}{2.2 \text{ A}} = \mathbf{54.55 \ \Omega}$

9. $R = \dfrac{V}{I} = \dfrac{120 \text{ V}}{4.2 \text{ A}} = \mathbf{28.571 \ \Omega}$

11. $R = \dfrac{V}{I} = \dfrac{24 \text{ mV}}{20 \ \mu\text{A}} = \mathbf{1.2 \ k\Omega}$

13. a. $R = \dfrac{V}{I} = \dfrac{120 \text{ V}}{9.5 \text{ A}} = \mathbf{12.632 \ \Omega}$

b. $t = 1 \cancel{\text{h}} \left[\dfrac{60 \ \cancel{\text{min}}}{1 \ \cancel{\text{h}}}\right]\left[\dfrac{60 \text{ s}}{1 \ \cancel{\text{min}}}\right] = 3600 \text{ s}$

$W = Pt = VIt$
$= (120 \text{ V})(9.5 \text{ A})(3600 \text{ s})$
$= \mathbf{4.1 \times 10^6 \ J}$

17. $R = \dfrac{\Delta V}{\Delta I} \Rightarrow \Delta V = R(\Delta I) = (2 \times 10^3)(400 \times 10^{-3}) = \mathbf{800 \ V}$

19. $P = \dfrac{W}{t} = \dfrac{420 \text{ J}}{7 \ \cancel{\text{min}}\left[\dfrac{60 \text{ s}}{1 \ \cancel{\text{min}}}\right]} = \dfrac{420 \text{ J}}{420 \text{ s}} = \mathbf{1 \ W}$

21. a. $8 \ \cancel{\text{h}}\left[\dfrac{60 \ \cancel{\text{min}}}{1 \ \cancel{\text{h}}}\right]\left[\dfrac{60 \text{ s}}{1 \ \cancel{\text{min}}}\right] = 28{,}800 \text{ s}$

$W = Pt = (2 \text{ W})(28{,}000 \text{ s}) = \mathbf{57.6 \ kJ}$

b. $\text{kWh} = \dfrac{(2 \text{ W})(8 \text{ h})}{1000} = \mathbf{16 \times 10^{-3} \ kWh}$

23. $P = VI = (3 \text{ V})(2 \text{ A}) = 6 \text{ W}$

$t = \dfrac{W}{P} = \dfrac{12 \text{ J}}{6 \text{ W}} = \mathbf{2 \ s}$

25. $P = I^2R = (7 \times 10^{-3}\text{A})^2(4 \ \Omega) = \mathbf{196 \ \mu W}$

27. $I = \sqrt{\dfrac{P}{R}} = \sqrt{\dfrac{64 \text{ W}}{4 \ \Omega}} = \sqrt{16} = \mathbf{4 \ A}$

29. $V = \sqrt{PR} = \sqrt{(42 \text{ mW})(2.2 \text{ k}\Omega)} = \sqrt{92.40} = \mathbf{9.61 \text{ V}}$

31. $P = VI, I = \dfrac{P}{V} = \dfrac{100 \text{ W}}{120 \text{ V}} = \mathbf{0.833 \text{ A}}$

$R = \dfrac{V}{I} = \dfrac{120 \text{ V}}{0.833 \text{ A}} = \mathbf{144.06 \ \Omega}$

33. a. $P = EI$ and $I = \dfrac{P}{E} = \dfrac{0.4 \times 10^{-3} \text{ W}}{3 \text{ V}} = \mathbf{0.133 \text{ mA}}$

b. Ah rating = (0.133 mA)(500 h) = **66.5 mAh**

35. c. $I = \sqrt{\dfrac{P}{R}} = \sqrt{\dfrac{500 \text{ mW}}{100 \ \Omega}} \sqrt{5 \times 10^{-3}} \cong \mathbf{70.7 \text{ mA}}$

37. a. $P = EI = (120 \text{ V})(100 \text{ A}) = \mathbf{12 \text{ kW}}$

b. $P_T = 5 \cancel{\text{hp}} \left[\dfrac{746 \text{ W}}{\cancel{\text{hp}}}\right] + 3000 \text{ W} + 2400 \text{ W} + 1000 \text{ W}$

$= 10{,}130 < 12{,}000 \text{ W}$ **(Yes)**

39. $\eta = \dfrac{P_o}{P_i}, P_i = \dfrac{P_o}{\eta} = \dfrac{(1.8 \cancel{\text{hp}})(746 \text{ W}/\cancel{\text{hp}})}{0.685} = 1960.29 \text{ W}$

$P_i = EI, I = \dfrac{P_i}{E} = \dfrac{1960.29 \text{ W}}{120 \text{ V}} = \mathbf{16.34 \text{ A}}$

41. a. $P_i = EI = (120 \text{ V})(2.4 \text{ A}) = 288 \text{ W}$

$P_i = P_o + P_{\text{lost}}, \ P_{\text{lost}} = P_i - P_o = 288 \text{ W} - 50 \text{ W} = \mathbf{238 \text{ W}}$

b. $\eta\% = \dfrac{P_o}{P_i} \times 100\% = \dfrac{50 \text{ W}}{288 \text{ W}} \times 100\% = \mathbf{17.36\%}$

43. a. $P_i = \dfrac{P_o}{\eta} = \dfrac{(2 \text{ hp})(746 \text{ W/hp})}{0.9} = \mathbf{1657.78 \text{ W}}$

b. $P_i = EI = 1657.78 \text{ W}$

$(110 \text{ V})I = 1657.78 \text{ W}$

$I = \dfrac{1657.78 \text{ W}}{110 \text{ V}} = \mathbf{15.07 \text{ A}}$

c. $P_i = \dfrac{P_o}{\eta} = \dfrac{(2 \cancel{\text{hp}})(746 \text{ W}/\cancel{\text{hp}})}{0.7} = 2131.43 \text{ W}$

$P_i = EI = 2131.43 \text{ W}$

$(110 \text{ V})I = 2131.43 \text{ W}$

$I = \dfrac{2131.43 \text{ W}}{110 \text{ V}} = \mathbf{19.38 \text{ A}}$

45. $\eta_T = \eta_1 \cdot \eta_2 = (0.87)(0.75) = 0.6525 \Rightarrow \mathbf{65.25\%}$

47. $\eta_T = \eta_1 \cdot \eta_2 = 0.72 = 0.9\eta_2$

$$\eta_2 = \frac{0.72}{0.9} = 0.8 \Rightarrow \mathbf{80\%}$$

49. a. $\eta_T = \eta_1 \cdot \eta_2 \cdot \eta_3 = (0.98)(0.87)(0.21) = 0.1790 \Rightarrow \mathbf{17.9\%}$

b. $\eta_T = \eta_1 \cdot \eta_2 \cdot \eta_3 = (0.98)(0.87)(0.90) = 0.7673 \Rightarrow \mathbf{76.73\%}$

$$\frac{76.73\% - 17.9\%}{17.9\%} \times 100\% \Rightarrow \mathbf{328.66\%}$$

51. a. $W = Pt = \left[\frac{V^2}{R}\right]t = \left[\frac{15\text{ V}}{10\ \Omega}\right]^2 60\text{ s} = \mathbf{1350\ J}$

b. Energy doubles, power the same

53. $\text{kWh} = \frac{Pt}{1000} \Rightarrow t = \frac{(1000)(\text{kWh})}{P} = \frac{(1000)(10\text{ kWh})}{1500\text{ W}} \doteq \mathbf{6.67\ h}$

55. a. $\text{kWh} = \frac{Pt}{1000} \Rightarrow P = \frac{(1000)(\text{kWh})}{t} = \frac{(1000)(500\text{ kWh})}{10\text{ s}} = \mathbf{50\ kW}$

b. $I = \frac{P}{E} = \frac{50 \times 10^3\text{ W}}{208\text{ V}} = \mathbf{240.38\ A}$

c. $P_{\text{lost}} = P_i - P_o = P_i - \eta P_i = P_i(1 - \eta) = 50\text{ kW}(1 - 0.82) = \mathbf{9\ kW}$

$$\text{kWh}_{\text{lost}} = \frac{Pt}{1000} = \frac{(9\text{ kW})(10\text{ h})}{1000} = \mathbf{90\ kWh}$$

57. $\text{kWh} = \frac{(860\text{ W})(24\text{ h}) + (4800\text{ W})(1/2\text{ h}) + (400\text{ W})(1\text{ h}) + (1200\text{ W})(0.75\text{ h})}{1000}$

$= \mathbf{24.34\ kWh}$

$24.34\ \cancel{\text{kWh}}[9¢/\cancel{\text{kWh}}] = \mathbf{\$2.19}$

CHAPTER 4 (Even)

2. $I = \frac{V}{R} = \frac{12\text{ V}}{72\ \Omega} = \mathbf{166.67\text{ mA}}$

4. $I = \frac{V}{R} = \frac{12\text{ V}}{0.056\ \Omega} = \mathbf{214.29\text{ A}}$

6. $I = \frac{V}{R} = \frac{62\text{ V}}{15\text{ k}\Omega} = \mathbf{4.133\text{ mA}}$

8. $I = \frac{V}{R} = \frac{120\text{ V}}{7.5\text{ k}\Omega} = \mathbf{16\text{ mA}}$

10. $R = \frac{V}{I} = \frac{120\text{ V}}{0.76\text{ A}} = \mathbf{157.89\ \Omega}$

12. $V = IR = (15\text{ A})(0.5\ \Omega) = \mathbf{7.5\text{ V}}$

20. $t = \frac{W}{P} = \frac{640\text{ J}}{40\text{ W}} = \mathbf{16\text{ s}}$

22. $I = \frac{Q}{t} = \frac{300\text{ C}}{1\text{ min}}\left[\frac{1\text{ min}}{60\text{ s}}\right] = 5\text{ C/s} = 5\text{ A}$
$P = I^2R = (5\text{ A})^2\ 10\ \Omega = \mathbf{250\text{ W}}$

24. $I = \frac{48\text{ C}}{\text{min}}\left[\frac{1\text{ min}}{60\text{ s}}\right] = 0.8\text{ A}$
$P = EI = (6\text{ V})(0.8\text{ A}) = \mathbf{4.8\text{ W}}$

26. $P = \frac{V^2}{R} = \frac{(9 \times 10^{-3}\text{ V})^2}{3\ \Omega} = \mathbf{27\ \mu W}$

28. $I = \sqrt{\frac{P}{R}} = \sqrt{\frac{0.5\text{ W}}{1\text{ k}\Omega}} = \mathbf{22.36\text{ mA}}$

30. $P = EI = (9\text{ V})(45\text{ mA}) = \mathbf{405\text{ mW}}$

32. $V = \frac{P}{I} = \frac{450\text{ W}}{3.75\text{ A}} = \mathbf{120\text{ V}}$
$R = \frac{V}{I} = \frac{120\text{ V}}{3.75\text{ A}} = \mathbf{32\ \Omega}$

34. $I = \sqrt{\frac{P}{R}} = \sqrt{\frac{100\text{ W}}{20\text{ k}\Omega}} = \sqrt{5 \times 10^{-3}} = \mathbf{70.71\text{ mA}}$
$V = \sqrt{PR} = \sqrt{(100\text{ W})(20\text{ k}\Omega)} = \mathbf{1.414\text{ kV}}$

36. a. $P = EI = (9\text{ V})(0.455\text{ A}) = \mathbf{4.095\text{ W}}$ b. $R = \frac{E}{I} = \frac{9\text{ V}}{0.455\text{ A}} = \mathbf{19.78\ \Omega}$

c. $W = Pt = (4.095\text{ W})(21{,}600\text{ s}) = \mathbf{88.45\text{ kJ}}$

$$6\,\text{h}\left[\frac{60\text{ min}}{1\text{ h}}\right]\left[\frac{60\text{ s}}{1\text{ min}}\right] = 21{,}600\text{ s}$$

38. $$\eta = \frac{P_o}{P_i} \times 100\% = \frac{(0.5\text{ hp})\left[\frac{746\text{ W}}{\text{hp}}\right]}{450\text{ W}} \times 100\% = \frac{373}{450} \times 100\% = \mathbf{82.89\%}$$

40. $$\eta = \frac{P_o}{P_i} \times 100\% = \frac{746\text{ W}}{(4\text{ A})(220\text{ V})} \times 100\% = \frac{746}{880} \times 100\% = \mathbf{84.77\%}$$

42. $$P_i = EI = \frac{P_o}{\eta} \Rightarrow I = \frac{P_o}{\eta E} = \frac{(3.6\text{ hp})(746\text{ W/hp})}{(0.87)(220\text{ V})} = \mathbf{14.03\text{ A}}$$

44. $$P_i = \frac{P_o}{\eta} = \frac{(15\text{ hp})(746\text{ W/hp})}{0.9} = 12{,}433.33\text{ W}$$

$$I = \frac{P_i}{E} = \frac{12{,}433.33\text{ W}}{220\text{ V}} = \mathbf{56.52\text{ A}}$$

46. $\eta_1 = \eta_2 = 0.8$

$\eta_T = (\eta_1)(\eta_2) = (0.8)(0.8) = 0.64$

$$\eta_T = \frac{W_o}{W_i} \Rightarrow W_o = \eta_T W_i = (0.64)(60\text{ J}) = \mathbf{38.4\text{ J}}$$

48. $$\eta_T = \frac{P_o}{P_i} = \eta_1 \cdot \eta_2 = \eta_1 \cdot 2\eta_1 = 2\eta_1^2$$

$$\eta_1^2 = \frac{P_o}{2P_i} \Rightarrow \eta_1 = \sqrt{\frac{P_o}{2P_i}} = \sqrt{\frac{128\text{ W}}{2(400\text{ W})}} = 0.4$$

$\eta_2 = 2\eta_1 = 2(0.4) = 0.8$

$\therefore\ \eta_1 = \mathbf{40\%},\ \eta_2 = \mathbf{80\%}$

50. a. $$1\text{ watt}\cdot\text{hour}\left[\frac{60\text{ min}}{1\text{ h}}\right]\left[\frac{60\text{ s}}{1\text{ min}}\right]\left[\frac{1\text{ J}}{1\text{ watt}\cdot\text{sec}}\right] = \mathbf{3600\text{ J}}$$

$$1\text{ kWh}\left[\frac{1000\text{ Wh}}{1\text{ kWh}}\right]\left[\frac{3600\text{ J}}{1\text{ Wh}}\right] = \mathbf{3.6 \times 10^6\text{ J}}$$

b. For large energy applications the numbers would be enormous if joules were employed. For low levels of energy consumption the use of joules can be appropriate.

52. $\dfrac{12\text{ h}}{\text{week}}\left[\dfrac{4\frac{1}{3}\text{ weeks}}{1\text{ month}}\right][5\text{ months}] = 260\text{ h}$

$$\text{kWh} = \frac{(230\text{ W})(260\text{ h})}{1000} = \mathbf{59.80\ kWh}$$

54. $\text{kWh} = \dfrac{(30\text{ W})(3\text{ h})}{1000} = \mathbf{0.09\ kWh}$

$$(0.09\text{ kWh})(9¢/\text{kWh}) = \mathbf{0.81¢}$$

56. a. $\#\text{kWh} = \dfrac{\$1.00}{9¢} = 11.11$

$$\text{kWh} = \frac{Pt}{1000} \Rightarrow t = \frac{(\text{kWh})(1000)}{P} = \frac{(11.11)(1000)}{250} = \mathbf{44.44\ h}$$

b. $t = \dfrac{(\text{kWh})(1000)}{P} = \dfrac{(11.11)(1000)}{4800} = \mathbf{2.32\ h}$

58. $\text{kWh} = \dfrac{(110\text{ W})(4\text{ h}) + (1200\text{ W})(1/3\text{ h}) + (60\text{ W})(1.5\text{ h}) + (150\text{ W})(3\ 3/4\text{ h})}{1000}$

$$= \frac{440\text{ Wh} + 400\text{ Wh} + 90\text{ Wh} + 562.5\text{ Wh}}{1000} = 1.4925\text{ kWh}$$

$1.4925\text{ kWh}[9¢/\text{kWh}] = \mathbf{13.43¢}$